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COMBINED CONVERSION OF POTATOES TO ALCOHOL AND
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COMBINED CONVERSION OF POTATOES TO ALCOHOL AND STARCH

by

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In connection with the increased manufacture of synthetic alcohol the production load of alcohol plants converting agricultural raw materials has been reduced recently. At the same time, because of inadequate capacities of starch plants, the production of food starch, nevertheless, lags behind demands. Therefore, the organization of combined conversion of potatoes to alcohol, starch and feed in alcohol plants located in well-developed potato growing regions is one of the most rational and prospective directions in the operation of many alcohol plants.

Combined processing of potatoes will make it possible to increase the output of starch enormously, make most efficient use of the technical and raw material base of alcohol plants, and at the same time more completely utilize the entire composition of processed potatoes.

In processing potatoes in marketable form in specialized starch plants no more than 82% of the starch is extracted and the rest becomes waste of little value; sugar, protein and other organic and mineral substances contained in the cell juice of the potato are irretrievably lost with washing water.

Studies of the cell juice of the potato in the laboratory of the Central Scientific Research Institute of the Alcohol Industry (TsNIISP) in 1959-1960 revealed the following composition:

Content in %

Dry matter	7.5
Reducing matter	
before hydrolysis	0.92
after hydrolysis	1.05
Pentoses	0.06
Nitrogen	
total	0.42
amine	0.03
Phosphorus	0.06
Ash	0.51

Losses in processing potatoes kept at low temperatures are especially great; a significant part of the starch (up to 7%) is converted to sugar.

These sugars are found primarily in the cell juice of the potato. Studies of individual samples of this juice have shown that their content of reducing matter before hydrolysis is 2.68% and after hydrolysis 4.73% with total dry matter of 7.7%.

In combined processing of potatoes approximately 50% of the starch contained in the potato is converted to food starch but all the rest with a large part of cell juice is directed to alcohol production. Feed grain is additionally enriched with proteins and carbohydrates by the extracted cell juice.

On the basis of studies conducted by TsNIISP, together with the starch-syrup industry, a production cycle has been developed for the combined conversion of potatoes in alcohol plants which is based on specifications worked out by the design institute Giprosptivno.

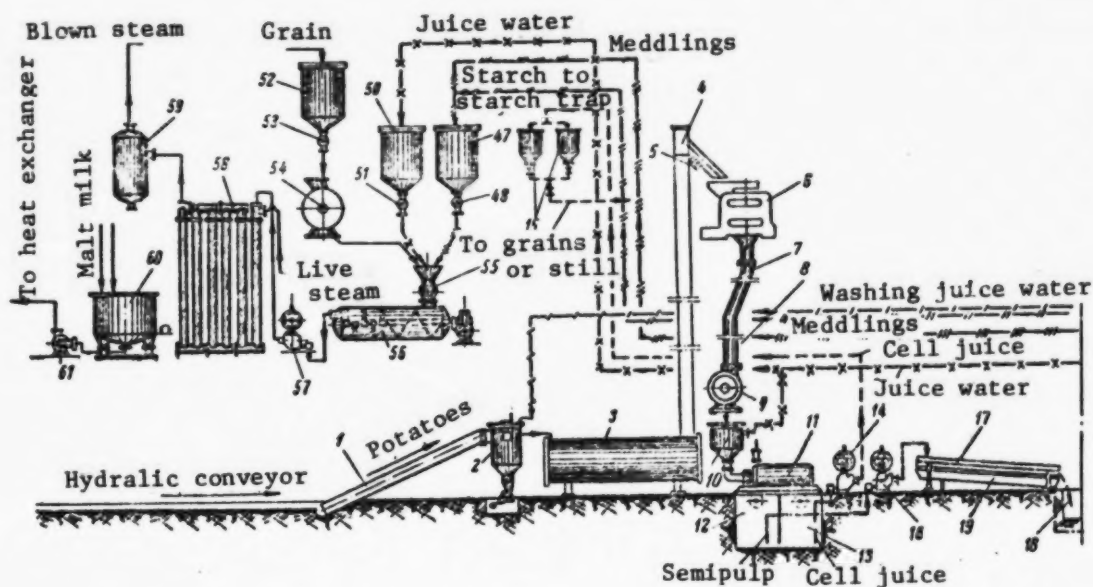
According to this plan (see illustration) potatoes, carefully washed and freed of foreign material, are directed through automatic scales to the potato rasper.

The resulting potato pulp is diluted in the receiving bin with juice water and fed into the 1st settling-washing centrifuge for separation of the cell juice.

In processing frost-bitten potatoes the cell juice is directed to the alcohol plant still. In processing normal potatoes the cell juice is introduced to feed grain or used as an additive in the nutrient medium for cultivating fungi used instead of grain malt, for cultivation of feed and baker's yeast or in the production of feed biomyacin.

Potato pulp (semipulp), after passing through the settling-washing centrifuge, is pumped over a separating serge shaker seive where it is sprayed with water and about 50% of the starch passing through the seive is extracted in the form of starch "milk" for later processing in the starch department. The remaining starch in the form of coarse middlings is sent from the seive to a hopper and later to the still collector of the alcohol plant.

Starch milk from the serge seive is pumped to a settling centrifuge for separation of juice water. The starch extracted in the centrifuge is fed into refining sieves to separate remaining fine middlings. The starch milk from the refining sieves is pumped to a 2nd settling-washing centrifuge for extraction of juice water and fine middlings passed through the refining sieves enters a hopper where it is mixed with coarse middlings and together they are pumped to the still collector of the alcohol plant.



- Product
- Semipulp
- Pulp from rasper
- Middlings
- Cell juice
- Juice water
- Washing juice water
- Starch milk
- Clean slurry starch

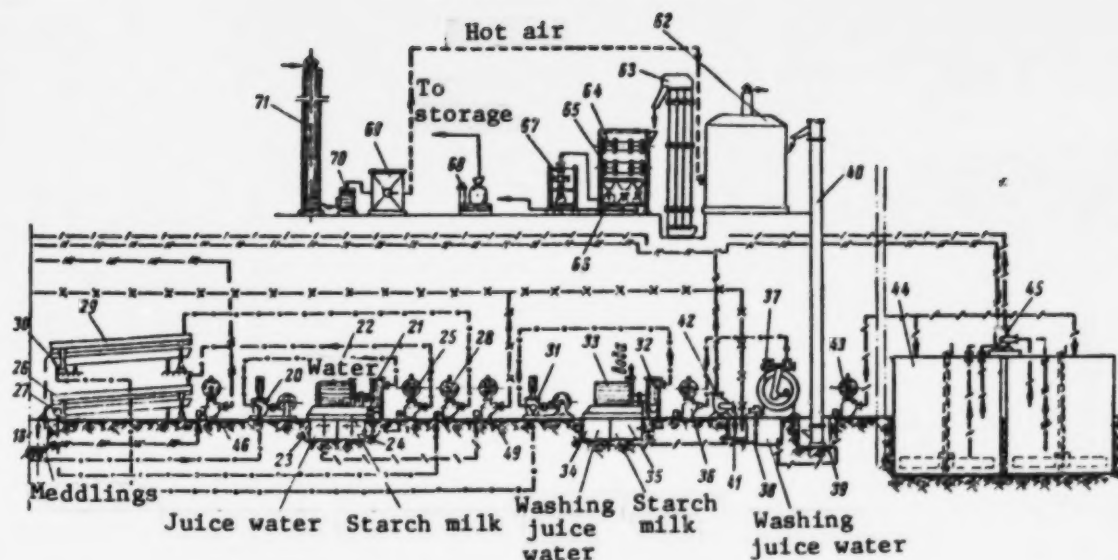


Diagram of combined conversion of potatoes to alcohol and starch

1 - screw conveyer; 2 - stone trap; 3 - potato washer; 4 - bucket chain elevator for potatoes; 5 - magnetic separator; 6 - automatic scales; 7 - duct; 8 - stirrer; 9 - potato rasper; 10 - pulp vat; 11 - 1st settling-washing centrifuge; 12 - semipulp hopper; 13 - cell juice hopper; 14 - displacement pump for cell juice; 15 - cell juice collector; 16 - displacement pump for semipulp; 17 - serge shaker seive; 18 - middlings hopper; 19 - starch milk hopper; 20 - pump for starch milk; 21 - expander; 22 - settling centrifuge; 23 - juice water hopper; 24 - starch milk hopper; 25 - displacement pump for starch milk; 26 - 1st refining seive; 27 - starch milk hopper; 28 - pump for starch milk; 29 - 2nd refining seive; 30 - starch milk hopper; 31 - California pump; 32 - expander; 33 - 2nd settling-washing centrifuge; 34 - juice water hopper; 35 - starch milk hopper; 36 - pump for starch milk; 37 - drying centrifuge; 38 - juice water hopper; 39 - crude starch hopper; 40 - bucket chain elevator to deliver crude starch to dryer; 41 - starch slurry hopper; 42 - centrifuge pump; 43 - pump for juice water; 44 - middlings collector; 45 - middlings batcher; 46 - juice water pump; 47 - juice water collector; 48 - juice water batcher; 49 - grain hopper; 50 - grain batcher; 51 - hammer mill; 52 - mixer; 53 - pre-still; 54 - displacement pump; 55 - tube still; 56 - steam separator; 57 - saccharification unit; 58 - sorting chamber; 59 - starch bin; 60 - brush mill; 61 - scales; 62 - air heater; 63 - ventilator; 64 - air intake shaft.

The majority of alcohol plants can be limited to the production of crude starch which is then sent to starch-syrup plants for further processing. In these cases starch not requiring prolonged storage and destined for shipment is sent to a drying centrifuge to reduce moisture to 40%. When prolonged storage is necessary, after passing through the 2nd settling-washing centrifuge the starch milk is pumped to liquid storage barrels, bypassing the drying centrifuge.

Juice water from the settling centrifuge is directed to the alcohol plant for distillation of grain raw material if the latter is processed.

In plants with departments for the production of feed yeast, juice water from the settling centrifuge can be used as a medium for cultivation.

All unused juice water is sent to the starch trap-settling tank.

The approximate balance of products in the raw starch section of an alcohol plant processing 100 T of potatoes with an 18.5% starch content is given in Table 1.

Table 1

Name of station	Product	Amount of product in T	Composition in %		
			moisture	dry matter	starch
	Potatoes	100.0	75.0	25.0	18.5
Washer	Potatoes	101.0	75.3	24.7	18.3
Rasper	Pulp	101.0	75.3	24.7	18.3
1st settling-washing centrifuge	Cell juice	50.0	96.0	4.0	0.16
	Semipulp	101.0	77.3	22.7	18.2
Serge shaker	Starch milk	161.0	92.4	7.6	5.7
seive	Coarse middlings	90.0	88.0	12.0	9.11
Settling centrifuge	Starch milk	53.0	80.0	20.0	17.2
	Juice water	133.0	98.8	1.2	0.05
Refining seive	Starch milk	156.0	94.0	6.0	5.9
	Fine middlings	11.0	88.0	12.0	9.11
2nd settling-washing centrifuge	Juice water	133.0	99.84	0.16	0.04
	Starch milk	37.0	75.0	25.0	24.9
Settling centrifuge	Water	21.4	100.0	—	—
	Crude starch	15.2	40.0	60.0	59.2

According to this balance the following products are produced by the starch department:

	Total weight in %	Including in T		
		moisture	dry matter	starch
Cell juice	50	48	2.0	0.07
Middlings	101	88.9	12.1	9.20
Juice water after passing through settling centrifuge	133	131.4	1.6	0.06
Juice water after passing through settling-washing centrifuge	133	132.8	0.2	0.06

Ways of further utilization of industrial water are given in Table 2.

Table 2

With which product water is obtained	Amount in % of weight of potatoes	Further use of water
Cell juice	48	In the cultivation of yeast, fungi, actinomycetes added to grains or trans- ferred to still
Middlings	89	To still
Juice water after passing through settling centrifuge	133	a) for addition to 1st settling-washing centrifuge b) to still
Juice water after passing through settling-washing centrifuge	133	To potato washer

After leaving the settling centrifuge the starch is fed into the dryer. Dried to 20% moisture content the starch reaches the chambers where it is cooled and separated into lumps which as they accumulate are fed into a brush mill for crushing. The finished product is weighed and bagged.

In equipping the drying department it is advisable to use hydrocyclones instead of the 2nd settling-washing centrifuge.

In processing 100 T of potatoes with an 18.5% starch content the yield of dry starch with 20% moisture content is 11.4%, or 9.12 T of absolutely dry starch.

In cases when an alcohol plant with a starch department processes potatoes alone, without the addition of grain raw material, in order to maintain the concentration of intermediate products of the alcohol plant at a level to ensure no less than 7.0-7.5% alcohol content of spirits, it is advisable to remove not more than 30-35% of the starch in the form of a marketable product (crude starch) and the remaining 60-70% use in the production of alcohol.

In this case not all the potato pulp is sent to the starch department, but approximately two thirds of the total amount. The rest is processed in a mixture with coarse and fine middlings, received from the starch department.

On the basis of further studies and the operation of starch departments certain changes can be introduced into the production cycle and the composition of intermediate products taking into account local conditions and characteristics of the raw material.

The production cycle of an alcohol plant in principle remains unchanged with the combined processing of potatoes. As a crushed product is introduced into the alcohol plant, heat treatment (distillation) should be conducted continuously.